BACKGROUND OF THE INVENTION

Miniature pushbutton switches, which are commonly soldered to circuit boards, often work in conjunction with illumination sources such as a light pipe to illuminate the depressable portion of the pushbutton. The light pipes generally cannot withstand the temperatures (e. g. 250 C) used in reflow soldering. Other light sources such as LEDs (light emitting diodes) also can be damaged by such high temperatures used in soldering. A low cost miniature illuminated switch that could be soldered to a circuit board by reflow soldering, without requiring any further operation, would be of value.

SUMMARY OF THE INVENTION

In accordance with one embodiment of the present invention, an illuminated pushbutton switch is provided that is rugged and of low cost, and which can be readily soldered to a circuit board by reflow soldering. The switch includes a housing and a pushbutton assembly that is slideable in inward and outward directions on the housing. The pushbutton assembly includes a molded plastic frame and a plurality of conductors mounted on the frame, to be engaged by deflectable housing contacts that have termination ends to be soldered to the circuit board. An LED mounted on the frame, has a pair of leads connected to a pair of the conductors. The LED is surrounded by a dielectric pushbutton element that has an inner end fixed to the frame and an outer end lying forward of the LED, the pushbutton element providing heat isolation to protect the LED from excessive heating during reflow soldering.

The conductors mounted on the pushbutton frame, are formed of sheet metal. Inner ends of the pair of conductors that are connected to the LED leads, form crimp barrels that are crimped to the leads, to avoid loosening during reflow soldering. The pushbutton frame has a wide inner portion forming a contacting

surface on which the conductors are mounted. The pushbutton frame has a narrower outward extension through which the pair of sheet metal conductors extend, the extension closely receiving and latching to the pushbutton element.

The housing includes a molded plastic insulated bottom portion, and a sheet metal cover that is crimped to the bottom portion.

The novel features of the invention are set forth with particularity in the appended claims. The invention will be best understood from the following description when read in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is an isometric view of an illuminated switch constructed in accordance with the present invention.

Fig. 2 is a plan view of the switch of Fig. 1.

Fig. 3 is a side elevation view of the switch of Fig. 1, shown mounted on and soldered to a circuit board.

Fig. 4 is an outer end view of the switch of Fig. 1.

Fig. 5 is an exploded isometric view of the switch of Fig. 1.

Fig. 6 is an exploded isometric view of a portion of the switch of Fig. 5, showing tracks on the frame that are engaged by deflectable portions of housing contacts.

Fig. 7 is a schematic diagram showing how the conductors and contacts of Fig. 6 can be used .

Fig. 8 is a sectional view taken on line 8-8 of Fig. 6.

Fig. 9 is graph showing a typical temperature-time profile used in reflow soldering.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Fig. 1 illustrates an illuminated miniature pushbutton switch 10 of a type that is designed to be mounted on a circuit board. The switch includes a stationary housing 12 and a pushbutton assembly 14 that can slide in inward I and outward O directions on the housing. As shown in Fig. 3, the housing has a grounded sheet metal cover 16 that has terminals 20 that are soldered by solder joints 22 to grounded traces on the circuit board 23. Housing switch contacts 24 are mounted on an insulated main portion 30 of the housing and have terminal ends 25 that are soldered by solder joints 26 to signal traces such as 28 on the circuit board. The sheet metal cover is attached to the housing main portion by crimping the cover as at tabs 25, 27.

Fig. 5 shows that the housing 12 includes an insulated portion 30 on which the housing switch contacts 24 are mounted, in addition to the grounded sheet metal cover 16. The pushbutton assembly 14 includes a molded plastic dielectric (electrically insulative) pushbutton frame 32, a plurality of pushbutton conductors 34, and an LED light source 36 with leads 40, 42 that are connected to two of the pushbutton conductors. The pushbutton assembly also includes a pushbutton depressing element 44 that is manually depressed in the inward direction I along its axis 46. When the depressing element is in its outward position and is depressed inward, a double click mechanism 50 retains the element in its inward position. When the element is depressed again, the double click mechanism releases the element to move outward to its outward position. The double click mechanism includes a cam 52 molded into the pushbutton frame and a cam follower 54 that has an inward end pivotally mounted in a hole 56 of the housing. A pair of springs 58 bias the pushbutton assembly outward O.

The pushbutton conductors 34 are all formed of sheet metal. Two of the pushbutton conductors 60, 62 are lead conductors that are dedicated to carrying

electricity to the lead of the LED light source 36. An additional sheet metal pushbutton conductor 64 provides switching functions. The two lead conductors 60,62 have inward ends that form crimp portions, or crimp barrels 70,72 that are crimped around the LED leads. The crimp barrels lie outward of the frame 32 and are bent around axes that are parallel to axis 46. The bulb 74 (a clear plastic member that encapsulates a diode) of the LED extends outward of the leads. Inward portions of the three pushbutton conductors lie on a contacting surface 80 of an inward portion 82 of the dielectric pushbutton frame . The frame also has an outward extension 84. The lead conductors 60, 62 have portions 66 that extend though the frame extension, with the crimp barrels 70,72 lying outward of the frame extension. The conductors 60-64 can be bonded as by adhesive to the contacting surface 80 of the frame inward portion.

The inward portion 82 (Fig. 8) of the pushbutton frame has a small thickness or height T. The outward extension 84 of the frame has less than half the width of the inward portion, and is downwardly offset. This allows the pressing element top to lie about flush with the top of the frame inward portion. An empty volume is left under the contacting surface 80 of the frame inward portion, which is occupied by the deflectable housing contact portions.

Fig. 6 shows that the three pushbutton conductors 60-64 form five tracks, including two tracks 86, 88 on the two opposite lead conductors 60 and 64 that continually supply current to the LED, and three tracks 91-93 for the center pushbutton conductor 64. The two tracks 86, 88 are in continuous contact with two deflectable contact portions 96,98 of two housing contacts 106, 107. The three tracks 91-93 are in the paths of three deflectable switch contact portions 101-103 of three switching housing contacts 111-113. The pushbutton conductor 64 has an outward gap 116 at the outer end of the track 91. The pushbutton conductor has an inward gap 118 at the inward end of the track 93. The track 92 does not

have any gaps along its length so it continually engages deflectable switch contact portion 102.

When the pushbutton depressor element 44 is pushed inward I to move the pushbutton assembly to its inward position, the housing deflectable contact portions 101-103 press against points 121-123. One of the deflectable contact portions 101 engages the insulative contacting surface 80 at the gap 116. Thus, any circuit wherein current sometimes flows between the contact portions 102 and 101, is an open circuit. Similarly, When the pushbutton element is pushed in again and the pushbutton assembly moves to its outward position, the deflectable contact portion 103 engages the contacting surface 80 at the gap 118. Fig. 7 shows an electrical circuit representing the switch 10 of Fig. 6.

It would be possible to form the deflectable contact portions 96, 98 and 101-103 on the pushbutton conductors that are mounted on the slideable frame, instead of on contacts that are mounted on the housing. However, this would result in free deflectable contact portions that slide in and out. This would have the disadvantage that such in-and-out sliding deflectable contact portions could catch on something (e.g. an accidentally protruding part) and damage the switch, and would be more difficult to manufacture.

Fig. 8 shows that the pushbutton depressor element 44 has a through passage 130 that receives the LED 36. An inward portion 132 of the passage walls is closely received in the outward extension 84 of the pushbutton frame, so there is substantially no tilt (no more that 3°) of the depressing element with respect to the frame. A pair of lugs 136 on the frame extension snap into holes 138 to lock the depressing element on the frame. The outer end portion 140 of the passage walls are constricted and project outward O of the LED bulb 84. This helps protect the bulb from heat that is applied during soldering of the switch 10 to the circuit board as is shown in Fig. 3.

Fig. 9 contains a graph 150 that shows the temperature-time profile of the air temperature and of the temperature of the cover 16 and of the housing contact terminals that are all to be soldered (by a lead-free solder) to traces on the circuit board. The graph 150 shows the temperatures as the fully assembled switch passes through a reflow oven that heats solder preforms that have been applied to the locations where solder joints are to be formed. The solder is a lead-free composition that melts at about 250 C. The outer end portion 140 (Fig. 8) of the depressor element passage walls helps insulate the bulb 74 of the LED from the maximum heat applied to the solderable parts in the oven. The reduced diameter of the outer end 160 of the outer passage walls helps protect the bulb from damage, especially because there is no transparent window over the outer end. The fact that the inner end 132 of the depressor element is blocked by the frame extension 84, prevents hot air from flowing through the passage of the depressor element, to thereby further reduce heating of the bulb. In the particular LED 36, the bulb could be damaged by heating it to 250° C.

In a switch of the construction shown that applicant has designed and constructed, the switch had an overall length A (Fig. 2 and 3) of 28.5 millimeters between the outer end of the depressable element in its outward position, and the inward end of the housing cover. The depressable element had a width W of 6mm and a height H of 4mm.

Thus, the invention provides a circuit board-mountable, compact and low cost miniature illuminated pushbutton switch where the light source such as an LED, is mounted on a manually operable depressor element of the pushbutton assembly. A plurality of sheet metal fixed conductors mounted on a dielectric pushbutton frame, include two lead conductors fixed to the frame and fixed to two LED leads by crimping of rear ends of the conductors around the leads. The pushbutton frame has an inner portion of large width and small height , against

which housing conductor resilient portions press. The frame has an offset outward extension, and the two lead conductors extend through a slit in the extension to their crimp locations. The depressor element has a passage that surrounds the LED, the passage having a front end of reduced diameter that lies forward of the bulb.

Although particular embodiments of the invention have been described and illustrated herein, it is recognized that modifications and variations may readily occur to those skilled in the art, and consequently, it is intended that the claims be interpreted to cover such modifications and equivalents.